Attorney Docket No. 60896 (70551)
Application Ser. No. 10/787,037
Applicant: A. Sugiyama

Examiner: Karla A. Moore
Art Unit: 1763

REMARKS

Amendments are being made to the Specification to correct clerical errors. Support for the change in the Specification on page 13, line 28 is found in Figures 1, 2, 6, 7, 12, and 13, which all show clearly that item 16 refers to the exhaust line. Furthermore, all other references in the specification to item 16 identify it as "exhaust line 16." Also, support for the change in the Specification on page 18, line 8 is found in Figures 1, 5, 6, 10, 11, 12, and 13, which all show clearly that item 5 refers to the gas exhaust opening. Furthermore, all other references in the Specification to item 5 identify it as "gas exhaust opening 5." No new matter has been added.

Claim 1 has been amended to more particularly point out and distinctly claim the subject matter that the Applicant regards as the invention. No new matter has been added.

Support for the claim amendments and additions can be found throughout the specification and claims as originally filed. In particular, support the amendments to claim 1 can be found at least, for example, in the Specification at page 4, lines 12-17. The "processing gas is supplied *through* the supply opening provided on the first opposing surface to the surface of the object..." and it "is exhausted from the surface of the object *through* the exhaust opening provided on the second opposing surface..." [emphasis added]. The gas supply 4 and gas exhaust 5 openings are shown Figures 1, 5, 6, 11, 12, and 13, which confirm that they are located within the proximities of the surfaces of the respective electrodes which are opposite to the surface of the object being treated.

Amendment of the claims herein are not to be construed as acquiescence to any of the rejections/objections set forth in the present Office Action, and were done solely to expedite prosecution of the present application. The Applicant hereby reserves the right to prosecute the claims as originally filed, or similar claims, in one or more continuation or divisional applications.

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In view of the present amendments and remarks, the Applicant believes that the claims are in condition for allowance. Should the Examiner disagree, the Applicant respectfully requests the Examiner to contact the Applicant's undersigned representative by telephone so that an interview may be scheduled prior to the mailing of any final Office Action.

Claim Rejections- 35 U.S.C. § 103(a)

Claims 1 – 11 are rejected under 35 U.S.C. 103(a) as being unpatentable of JP Patent Publication No. 2002-15149A to Yara et al. in view of 5,549,780 to Koinuma et al. Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over Yara et al. and Koinuma et al. as applied to claims 1 –11 above, and further in view of Japanese Patent No. 2001103199 A to Nakamura et al. The Applicant traverses the Examiner's rejections of claims 1 - 11, because none of the cited references teaches or suggests the mode of generating plasma described by the present invention.

Claim 1

The device in Yara et al. operates radically differently from that of the presently claimed device. In Yara et al., the inert gas is introduced in an empty space between the two electrodes. The plasma is formed in that space and travels vertically down the passage between the electrodes and strikes the surface of the object to be processed in a manner that is detrimental to its surface, causing pitting, sputtering, etc... This is the very effect which the present invention avoids. (See Specification p. 2, line 20 – p. 3 line 3) These problems, and others described at pages 2 – 3 of the present Specification arise because the gas in Yara et al. is exposed to the electric field when it is at its highest strength, in a space between the electrodes.

The present invention avoids the above problems in two ways. First, the volume between the electrodes is filled with dielectric, so no plasma is generated between the electrodes. Second, the gas supply opening is in the face of the electrodes which faces the surface of the object to be processed. Thus the plasma cannot be formed until it is in the vicinity of the surface of the object, and it is withdrawn through a gas exhausting opening in the face of the other electrode.

That causes the paths of the plasma to be oriented in a direction generally parallel to the surface of the object to be processed, rather than vertically impinging on its surface as in Yara et al.

According to the Office Action at page 2, the Examiner compares the first and second electrodes recited in claim 1 of the present application to electrodes 3 and 2, respectively, shown in Figure 3 of Yara et al., and compares the dielectric recited in claim 1 of the present application to the solid dielectric 4 shown in Yara et al. The Examiner also compares the gas exhausting means recited in claim 1 of the present application to the exhaust gas port 10 shown in figure 3 of Yara et al. The Examiner goes on to state at page 3 that it would have been obvious to one of ordinary skill in the art to have provided coated electrodes in Yara et al. in order to protect the electrodes from processing gases.

However, the dielectric recited in claim 1 of the present application fills the space between the first and second electrodes, which is not the case for the dielectric between electrodes 3 and 2 in Yara et al. As defined in claim 1, the "coated surfaces" recited in claim 1 refer to the dielectric-covered surfaces of the electrodes facing the surface of the object to be processed. (See Specification p. 9, lines 9 – 13, and Fig. 1) The electrodes 1 and 3 have coated surfaces 25, and electrode 2 has a coated surface 26, that face the surface of the object to be processed, and extend on a plane parallel to that surface. As noted in the Specification on page 9, lines 29 – 30, a dielectric "is provided filled between electrodes 1 and 2 and between electrodes 2 and 3 and covering surfaces 25 and 26."

Because the inert gas is contained within the body of the first electrode, it is not subjected to the field between the electrodes until it exits the gas supply opening in the dielectric coated surface of the first electrode which faces the surface of the object to be treated. Thus the plasma is formed at that opposing surface and travels to the exhaust opening in the dielectric coated surface of the second electrode, whence it exits the system. Thus the travel of the plasma is not generally vertically impinging on the surface of the object to be treated, but generally travels parallel to the surface to be treated, thus reducing surface defects and other problems. There is nothing in any of the references which discloses or suggests such a structure or approach.

Figure 3 of Yara et al. shows that although the dielectric covers the opposing electrodes, there is a space for the processing gas to flow between them, and the inert gas is fed through that very space. Review of the disclosure in Yara et al. confirms this. Raw gas is introduced between the counterelectrodes (Yara et al. at paragraphs 7, 19, and 21). Therefore, even in light of the disclosure of Koinuma et al. of an electrode that is "preferably formed of or coated thereon with gold, platinum or the like ..." (Koinuma et al., U.S. Pat. No. 5,549,780, col. 7, lines 28-33), neither of these references would have rendered the electrode and dielectric arrangement of the present application obvious.

Also, in claim 1 of the present application, the exhaust opening of the gas exhausting means is formed in the dielectric and its underlying electrode. In contrast, exhaust gas port 10 in Yara et al. is separate from the solid dielectric 4. In the present application, the fact that the surfaces of the electrodes are coated with dielectric does not render claim 1 obvious, because the references fail to teach or suggest the plasma generating configuration of the electrodes recited in claim 1.

Claim 3

The Applicant traverses the examiner's rejection of claim 3. The Office Action at page 3 states that although Yara et al. "do not explicitly teach forming a dielectric" at the gas exhausting means, one of ordinary skill in the art "would recognize that the dielectric could be formed at other locations to further enhance the benefits provided by the dielectric." (Office Action, p. 3, para. 9) In Yara et al., the dielectric is installed between the electrodes to prevent the discharge of an electric arc between the electrodes as the gas passes between them. (Yara et al., para. 44). In the present invention, the gas flow is within the respective electrodes until they reach the space containing the object to be treated. Thus placement of dielectric along the inner walls of the gas supply and exhaust channels would not have been rendered obvious by the prior art. Applying dielectric to the inner walls of the supply and exhaust channels prevents improper or abnormal electrical discharge or plasma formation, because the channels are formed within each electrode. (See Specification p. 5, lines 10-14) Thus, plasma generation in the region adjacent to the object to be processed -- which is not taught in the prior art – occurs with greater efficiency.

(See Specification p. 4, lines 29-31) For these reasons, the placement of the dielectric as recited in claim 3 of the present application would not have been obvious to one of ordinary skill in the art.

Claims 5, 7 and 10

The Office Action at page 3 states that "it is clearly taught that the processing characteristics can be customized by tailoring the electrode configuration (paragraph 71 of JPO online translation)," and that "where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation." (Office Action, para. 13) The Applicant traverses the Examiner's suggestion that claims 5, 7 and 10 are the product of routine experimentation.

Attached hereto are illustrations labeled (A) and (B) that further elucidate the differences in the electric lines of force generated by this invention compared to the prior art. Illustration (A) shows that the electric lines of force are substantially parallel to the object to be processed. As shown in illustration (B), this is unlike the device disclosed in Nakamura et al., in which the lines of force are perpendicular to the object to be processed. This is also unlike Yara et al., in which the plasma flow is perpendicular to and impinges upon the surface of the object to be processed. In the present invention, the gas is formed into a plasma as it travels in a direction substantially parallel to the surface of the object to be processed.

Regarding claim 7 of the present application, the recessed portion of the second electrode allows more plasma to be generated more efficiently in the region of the junction between the electrodes overlying the object to be processed. (See Specification p. 20, lines 11-13) Nothing in the prior art suggests or teaches the generation of plasma in the region overlying the object to be processed in the manner of the present invention. The radical change of structure and approach of the present invention could not have been the product of routine experimentation based on Yara et al. or the other references.

Regarding claim 10, plasma generation is improved in a nonobvious way by setting the minimum length of the outer edge of the dielectric-covered electrodes to at least 4 times the

distance between the processing gas supply opening and exhaust opening. With this arrangement, a larger amount of processing gas can be provided to the plasma generation site (Specification p. 7, lines 7-10), and the relative sizes of the electrodes are optimized. (Specification p. 7, lines 11-12) Thus, not only is the flow of plasma over the surface of the object increased, but the generation of plasma is also more efficient. (See Specification p. 16, lines 5-19). Because the generation of plasma in the area adjacent to one surface of the object to be processed is not suggested or taught in the prior art, the relative sizes of the electrodes could not have been determined through routine experimentation.

Paragraph 71 of the translation of Yara et al. merely states that "parameters, such as pulse frequency, an electrical potential difference, and an electrode spacing, can also adjust the parameter about processing of a processed object." This statement is made in the context of achieving "high-speed processing" with the device of Yara et al., in which gas flows between the opposing electrodes to form the plasma, which is unlike the present invention. The prior art therefore does not teach one skilled in the art how to modify the relative sizes and shapes of the electrodes to provide greater *generation* of plasma over one surface of object to be processed.

Claim 12

Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over Yara et al. and Koinuma et al. as applied to claims 1 – 11, and further in view of Japanese Patent No. 2001103199 A to Nakamura et al. The Office Action states that "it would have been obvious to one of ordinary skill in the art at the time the Applicant's invention was made to have provided a third electrode in Yara et al. and Koinuma et al. in order to provide a lengthened plasma space for a conveyed substrate as taught by Nakamura et al." (Office Action, p. 4, para. 21) The Applicant traverses the Examiner's conclusion that claim 12 is obvious over the prior art.

While the electrode arrangement in this invention does provide a lengthened plasma generation space, the arrangement of the electrode polarities is also an inventive feature. "In the plasma processing apparatus structured in this manner, electric fields formed externally by the first, second and third electrodes cancel each other. Therefore a safer plasma processing apparatus can be provided." (Specification p. 7, lines 22-25) Furthermore, as long as the flow

rate of gas exhausted is at least as great as the flow rate of processing gas supplied, "leakage of gas from the space between opposing surface 30a and the surface 9a to be processed can be prevented." (Specification p. 6, lines 23-27 and pp. 16-17, lines 30-33) "Further, it is unnecessary to blow an inert gas or the like toward the surface of the object in order to protect the object from contaminating atmosphere. Therefore, the apparatus can be made smaller and the cost of the gas used for the apparatus can be reduced." (Specification p. 6, lines 28-31) These features of the three-electrode configuration recited in claim 12 are neither taught nor suggested in the prior art.

Nakamura et al. disclose a series of pairs of electrodes of one polarity on one side of the plasma generating space, facing a series of electrodes of the other polarity on the other side of the plasma generating space. (See Nakamura et al., Figs. 10 & 12). This is also a radically different approach from the present invention, as shown by the attached line-of-force analysis. In contrast, in the present invention the electrode 2 of one polarity is flanked on each side by electrodes 1 and 3 of the other polarity. This unique arrangement allows the processing gas to flow inward from electrodes 1 and 3, and to be exhausted through electrode 2. This results in greater plasma processing efficiency and reduced leakage of processing gas, neither of which are taught or suggested in the prior art.

CONCLUSION

In view of the foregoing amendments and remarks, favorable reconsideration and withdrawal of all rejections, and allowance of this application with claim 1 as amended are respectfully solicited. Should any of the claims not be found to be allowable, Applicant respectfully requests the Examiner to telephone Applicant's undersigned representative at the

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number below so that a telephonic interview may be scheduled. The Applicant thanks the Examiner in advance for this courtesy.

Respectfully submitted,
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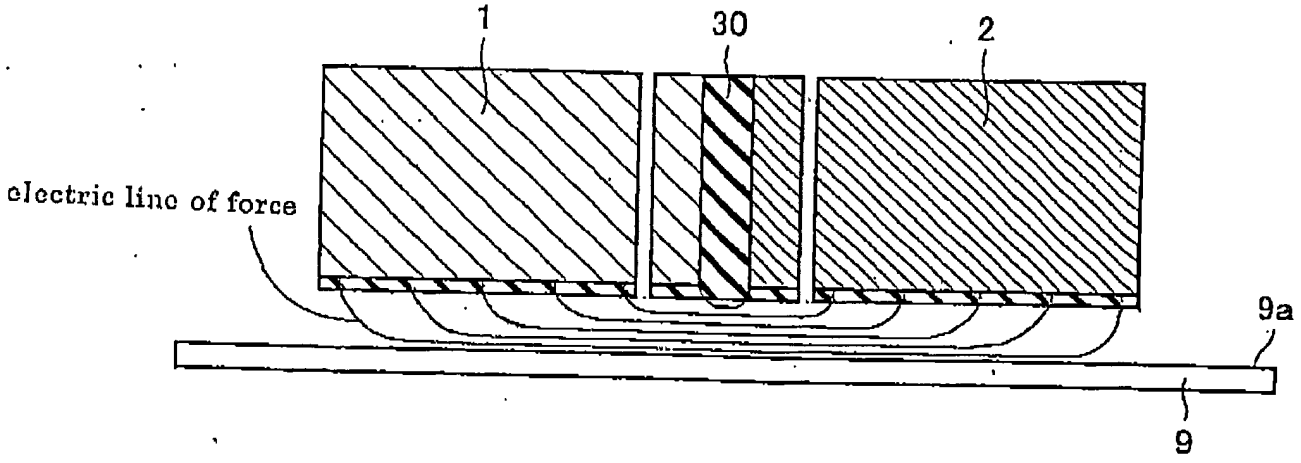
(A) The case where an electric line of force extends over and parallel to the surface of an object, as recited in claim 5



(B) The case where an electric line of force does not extend over and parallel to the surface of an object, illustrated for comparison